(12) UK Patent Application (19) GB (11) 2 356 037 (13) A

(43) Date of A Publication 09.05.2001

(21) Application No 9926091.1

(22) Date of Filing 03.11.1999

(51) INT CL[7]
F21K 7/00 2/00 , F21V 5/00 , H05B 33/06 39/04 , //
F21W 101:06 , F21Y 101:02

(52) UK CL (Edition S)
F4R RFG RS R213 R223 R225 R381 R388 R417 R478
R660 R693
H2H HLL4

(71) Applicant(s)
Page Aerospace Limited
(Incorporated in the United Kingdom)
Forge Lane, SUNBURY-ON-THAMES, Middlesex,
TW16 6EO, United Kingdom

(72) Inventor(s)
Paul Richard Gibbs

(74) Agent and/or Address for Service
Mathisen Macara & Co
The Coach House, 6-8 Swakeleys Road, Ickenham,
UXBRIDGE, Middlesex, UB10 8BZ, United Kingdom

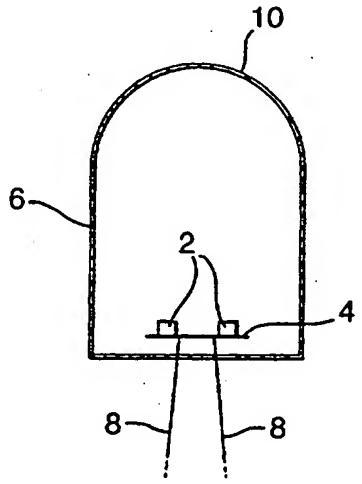
(56) Documents Cited
GB 2344230 A EP 0523903 A EP 0493800 A
US 5130531 A
PAJ ABSTRACT OF JP02018983 A (MATSUSHITA)
25.7.90

(58) Field of Search
UK CL (Edition R) F4R RCC RFC RFM RL RS , H2H
HLL2 HLL4
INT CL[7] F21K 7/00 , G09F 9/33 , H01L 33/00 , H05B
33/08 37/02 37/03 37/04 39/04 39/06 39/10
ONLINE: WPI, EPODOC, JAPIO

(54) Abstract Title
A semiconductor light source

(57) A semiconductor light source containing a semiconductor substrate 4 having a plurality of light emitting diodes 2 formed thereon which are electrically interconnected with connecting leads 8 such that each of th LED's 2 is separably operable to emit light. The light source comprises a transparent housing 6 incorporating a fresnel lens 10 so that the light emitted from the housing 6 is generally in the same direction and of the same intensity for light emitted from each of the LED's 2. A control circuit may be coupled to the connecting leads 8 of the light source and arranged to supply current to the LED's 2 to cause light to be emitted in a predetermined sequence with a predetermined duration of illumination for each diode 2, such that the light source appears to provide generally continuous light output of a generally constant intensity.

Fig.1.



GB 2 356 037 A

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

Fig.1.

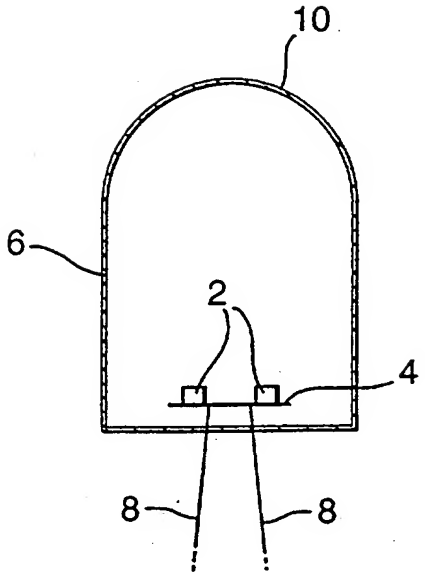


Fig.2.

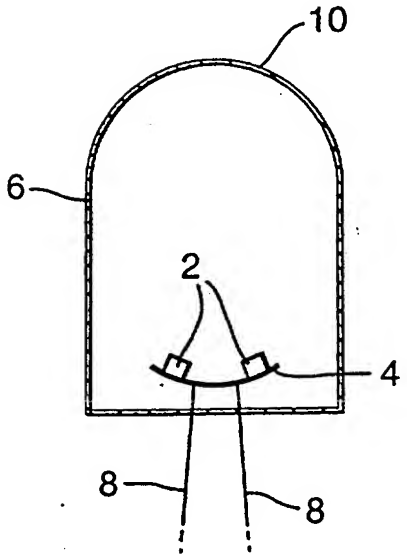
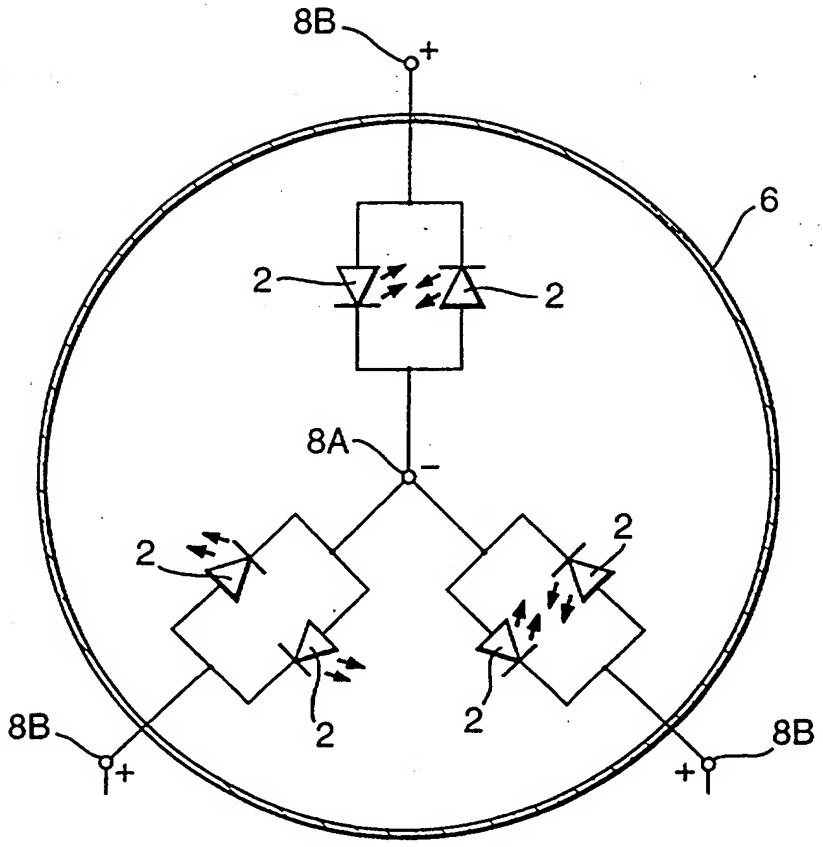


Fig.3.



A SEMICONDUCTOR LIGHT SOURCE

This invention relates to a semiconductor light source for use particularly though not exclusively, in the aircraft industry. Such light sources may for example be used in light fittings for passenger reading lights or the like.

In accordance with the invention, there is provided a semiconductor light source, comprising a transparent housing incorporating a lens, a semiconductor substrate contained in the housing, and a plurality of connecting leads which pass into the housing and form electrical connections to the substrate, the substrate having a plurality of light emitting diodes formed thereon which are electrically interconnected with the connecting leads such that each of the light emitting diodes is separately operable to emit light by causing current to flow in at least one pair of the connecting leads.

Semiconductor light sources embodying the invention will now be described by way of example with reference to the drawings in which:

Figure 1 is a cross-section of a semiconductor light source in accordance with the invention;

Figure 2 is a cross-section of an alternative semiconductor light source in accordance

with the invention; and

Figure 3 is a schematic plan view of a semiconductor light source in accordance with the invention showing possible interconnections for the LEDs.

With reference to Figure 1, a plurality of light emitting diodes (LEDs) 2 are formed on a substrate 4. The substrate 4 and LEDs 2 are mounted within a generally transparent plastics housing 6.

Connecting leads 8 pass through the housing 6 and make electrical connections with the substrate 4. Typically also, the connecting leads 8 serve to support the substrate 4 within the housing 6.

The upper part of the housing 6 is formed into a lens 10 to focus light emitted by the LEDs 2.

In a conventional LED package, only a single LED 2 is housed in the housing 6. It is known that LEDs have a limited operating life. Typically, for example, the brightness of an LED diminishes to 80% of its initial brightness after 2000 hours of operation. This is undesirable, for example, in the aircraft industry where a light may be required to operate within a specific brightness specification. In order to extend

the operating life of a semiconductor light source, therefore the present invention proposes the inclusion of several LEDs within a single housing 6 which may be in subsets (including individually) by allowing current to flow in various combinations of the connecting leads 8.

The subsets of LEDs within the housing 6 may be switched over a very long time period for example, several hours or may be switched at a relatively high frequency (sufficiently high that variations in light intensity due to the switching are not discernible by the human eye).

Preferably, the LEDs 2 within the housing 6 are packed closely together on the substrates (for example using a generally hexagonal shape to permit high densities). As the LEDs 2 are switched and depending on the characteristics of the lens 10, the direction and intensity of the light emitted from the lens 10 may vary depending on which subsets the LEDs 2 are illuminated at any given time. To overcome this problem, the lens 10 may have multiple foci by manufacturing the lens 10 as a Fresnel lens and/or by forming lens 10 with one or more aspherical lenses.

A further alternative embodiment is shown in Figure 2 in which the LEDs 2 are mounted in a generally curved configuration. This configuration may be used to minimise changes in the direction and intensity of light emitted from the lens 10 as

different subsets of the LEDs 2 are illuminated.

Figure 3 shows one possibility for interconnecting the LEDs within the housing 6. As will be seen, the LEDs 2 are interconnected in parallel pairs with the anode of the LED 2 of each pair connected to the cathode of the other pair. Furthermore, one end of the parallel pairs is connected in each case to a common connecting lead 8A and the other ends of the pairs are connected to connecting leads 8B. Using this interconnection scheme, it is possible to illuminate a single LED within each pair depending on the polarity of current passed between the connecting lead 8A and the respective connecting leads 8B. This arrangement is highly efficient in terms of the number of connecting leads required to control individual LEDs within the housing 6. In this case, any one of six LEDs may be controlled using only three connecting leads. In general, n connecting leads allows 2 (n-1) LEDs to be controlled using this configuration of parallel-connected pairs LEDs.

Other connection configurations are possible as will be appreciated by the skilled person.

Preferably, the invention includes a control circuit operable to switch automatically the LEDs in the housing 6 to achieve subjectively invariant light intensity whilst maximising the operating life of the light source. Such control circuitry may be

contained with the housing and more preferably, may be formed on the same substrate as the LEDs. This not only avoids the need to provide separate control circuitry but may also be used to reduce the number of connecting leads. The control circuitry may, for example, need only connections to a power supply and a current-limiting resistor.

The housing 6 may also include a light sensitive transducer (not shown) which is arranged to sense the brightness of one or more of the LEDs 2. The output of the transducer may be used by the control circuitry to charge the order and/or sequence of switching of the LEDs to ensure that the overall brightness of the light source is within a predetermined range.

One or more of the LEDs 2 may also be arranged to radiate at a relatively high energy wavelength (such as at ultraviolet wavelengths) and to irradiate a material such as a flourescent material that is arranged to re-radiate the energy in the visable spectrum (for example, as white light).

CLAIMS

1. A semiconductor light source, comprising a transparent housing incorporating a lens, a semiconductor substrate contained in the housing, and a plurality of connecting leads which pass into the housing and form electrical connections to the substrate, the substrate having a plurality of light emitting diodes formed thereon which are electrically interconnected with the connecting leads such that each of the light emitting diodes is separately operable to emit light by causing current to flow in at least one pair of the connecting leads.

2. A light source according to claim 1, wherein the housing incorporates a light emitting material which is generally absorbent of light energy at the wavelength of the energy radiated by the light emitting diodes such as ultraviolet light, and which re-radiates that energy as light of a different wavelength such as visible white light, when irradiated by light from the light emitting diodes.

3. A light source according to claim 1 or claim 2, wherein the lens is arranged to have multiple focal points such that the direction and intensity of light emitted from the housing is generally the same for light emitted from different ones of the light emitting diodes.

4. A light source according to claim 3, wherein the lens is a fresnel lens.

5. A light source according to claim 3 or claim 4, wherein the lens is aspherical.

6. A light source according to claim 1 or claim 2, wherein the lens has a single focal point and the light emitting diodes are arranged on a curve, the radius of the curve being such that each light emitting diode is generally the same radial distance from a predetermined point on the focal axis of the lens and such that the direction and intensity of light emitted from the housing is generally the same for light emitted from different ones of the light emitting diodes.

7. A light source according to any preceding claim, wherein the light emitting diodes are arranged in one or more pair, the or each pair being connected in parallel with the anode of one light emitting diode being coupled to the cathode of the other light emitting diode and vice versa, whereby current passed in one direction through the pair causes one of the diodes of the pair to emit light and current passed through the pair in the opposite direction causes the other diode of the pair to emit light.

8. A light source according to claim 7, including a plurality of the pairs, each pair being coupled at one end to a common connecting lead.

9. A light source according to any preceding claim, including a light sensitive

transducer operable to monitor the brightness of one or more of the light emitting diodes.

10. A control circuit couplable to the connecting leads of the light source of any preceding claim and arranged to supply current to the light emitting diodes to cause each light emitting diode to emit light in a predetermined sequence with a predetermined duration of illumination for each diode and such that the light source appears to provide generally continuous light output of a generally constant intensity.

11. A control circuit according to claim 10, located within the housing.

12. A control circuit according to claim 11, formed integrally on the substrate.

13. A light for the passenger compartment of an aircraft including a plurality of the semiconductor light sources of any of claims 1 to 9.

14 A light according to claim 13, further including the control circuit of any of claims 9 to 11.

15. A semiconductor light source constructed and arranged as described herein

with reference to the drawings.

Application No: GB 9926091.1 **Examiner:** Chris Archer
Claims searched: 1-9, 13 **Date of search:** 21 February 2000

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.R): F4R (RS, RL, RCC, RFM, RFC)

Int Cl (Ed.7): F21K (7/00) H01L (27/15B, 33/00B2) G09F (9/33, 13/22) H05B (33/08D)

Other: ONLINE: WPI, EPODOC, JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X,Y	EP 0493800 A2	(TEXAS) see Fig. 8 and column 7 lines 53 to 57.	(X) 1 (Y) 3,4,9
Y	US 5130531	(ITO) see Fig. 17 and column 12 lines 8 to 42, and the abstract.	3,4,9

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Application No: GB 9926091.1 **Examiner:** Chris Archer
Claims searched: 10-12 **Date of search:** 18 July 2000

Patents Act 1977
Further Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.R): H2H (HLL2, HLL4) F4R (RFC)

Int Cl (Ed.7): HO5B (37/02, 37/03, 37/04, 39/04, 39/06, 39/10)

Other: ONLINE: WPI, EPODOC, JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
A, E	GB 2344230 A (ANWYL-DAVIES)	
A	EP 0523903 A2 (INTERPLEX SOLAR)	
X	PAJ abstract of JP 020189893 A (MATSUSHITA) 25.7.90	10

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.